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Art. I.—*The Spirometer; its Use in detecting Disease of the Lungs.* By William Pepper, M. D., one of the Physicians of the Pennsylvania Hospital.

Notwithstanding the great degree of perfection now attained in the diagnosis of diseases of the chest, it must still be admitted, even by those most conversant with percussion and auscultation, that these means alone are occasionally inadequate for the detection of incipient phthisis. This is particularly true, too, in regard to disseminated tubercles of both lungs, and where a large portion of the pulmonary tissue yet remains in a healthy condition; under these circumstances, the percussion is but little if at all impaired, and being the same on both sides, can hardly afford any positive indication as to the true nature of the case. The same remark may in a measure be applied to auscultation; for, although a jerking inspiration with prolonged expiration, or a respiratory murmur puerile at one point and feeble at another, may lead us to suspect more or less pulmonary obstruction, it is still true that these signs are occasionally absent when the tubercles are small and equably scattered throughout the lungs. In such cases, the physical signs are frequently less important than the general symptoms, such as slight emaciation and debility, with perhaps more or less difficulty of breathing under slight exercise, or an occasional dry cough with some frequency of pulse; and these symptoms are entitled to the greatest consideration when occurring in one predisposed to phthisis, and particularly so if preceded by an attack of hæmoptysis.

By a careful combination of the general and local signs in connection with the previous history, a correct diagnosis can no doubt generally be made; but, for reasons already mentioned, there will be an occasional case in which these means may fail; and it is precisely under such circumstances that the spirometer is by some supposed to afford important aid. Dr. Hutchinson, in his elaborate report upon this subject (*Med.-Chir. Transactions*, vol. xxix.), mentions several very interesting cases in which he was enabled to predict the existence of pulmonary tubercles by means of the spirometer long before any of the usual signs could be detected; he also alludes to several instances where by aid of the same instrument he formed a correct diagnosis, and foretold the recovery of patients who had been considered by competent judges hopelessly ill of consumption; and from his large experience concludes that it is a precise, easy, and safe method of detecting disease of the lungs. His experiments, however, were more especially confined to healthy individuals; and, after patiently investigating more than 2000 cases, he has been enabled to deduce certain general rules by which the healthy standard of any given person may at once be estimated. Thus he found that, for every inch in height over five feet, the *vital capacity*, or amount of air expired after a forcible inspiration, was increased eight cubic inches, so that a person of six feet in height should have a capacity ninety-six inches more than one of only five feet. This conclusion appears the more remarkable from the well-known fact that the difference of height depends rather upon length of the lower extremities than of the trunk—the sitting height of most men (between five and six feet) being on an average about three feet. But what appears most to influence vital capacity is the mobility of the chest—as indicated by the difference between its circumference during forced inspiration and expiration—the average in healthy individuals being about three inches. A small chest having a large mobility will also have a larger vital capacity than one of much greater dimensions, and where the respiratory movements are imperfectly performed; hence, where the chest is much loaded with fat, its movements are embarrassed, and the capacity, consequently, diminished. Dr. Hutchinson found that, for every additional pound in weight from about 150 up to 155, the vital capacity was increased one cubic inch, but that from beyond this point it appeared to decrease in about the same proportion with any augmentation in weight. This rule, however, has reference to a fixed height of five feet six inches, and could only be applied to those of greater stature by first ascertaining the difference of weight in relation to height; this he found to be about five pounds for every inch, so that a man five feet six inches, weighing 150 pounds, an equivalent weight for one five feet eleven inches would be about 175 pounds; consequently up to this point his vital capacity should increase, whilst beyond it, it would diminish one cubic inch for every additional pound.

Age also appears to exercise an important influence: thus, it was ascertained, that the vital capacity increased from the fifteenth up to the thirtieth year, but that from this time it decreased at the rate of one and a half cubic inches for every additional year.

The average vital capacity in individuals aged about thirty, and weighing about 150 pounds, being 225 cubic inches, it appears reasonable to conclude that anything far short of this standard, and not explicable by the above-mentioned modifying circumstances, may be ascribed to some pathological condition either of the respiratory organs or abdominal viscera; the exact character, however, of the morbid condition could only be ascertained by a careful examination of the physical signs and general symptoms, since the diminished vital capacity might depend upon bronchitis, pleurisy, emphysema, chronic pneumonia, or tubercles. In like manner, an enlarged spleen or liver, an inflammation of the peritoneum or an effusion into its cavity would, by preventing the descent of the diaphragm, necessarily interfere more or less with the respiratory movements. How far the mobility of the chest, and consequently its capacity may be diminished by mere debility or want of muscular power, is a question of great importance in estimating the value of the spirometer; for, should it be ascertained that the vital capacity is in proportion to or even greatly influenced by the mere strength of the individual, it is evident that much caution should be exercised in the adoption of any indications afforded by this instrument as to the existence of pulmonary disease, since it is well known that deficiency of muscular power is by no means incompatible with general good health or perfect integrity of the different organs. Dr. Hutchinson, in alluding to the great power necessary for overcoming the elasticity of the ribs and lungs during forcible inspiration, states: "It is possible that the cachectic condition, in this early stage of the disease (tubercular phthisis), may disable the patient to overcome this resistance, and therefore the vital capacity become diminished by mere want of muscular power." The respiratory power is clearly proved by the same author to be much less in diseased than in healthy individuals, as might have been expected, because weakness is the most prominent symptom of disease; occupation also appeared to exercise an important influence in this respect, and hence the respiratory muscles were found to be more powerful in seamen, firemen, draymen, wrestlers, glassblowers, and trumpeters, than in gentlemen, compositors, and those who led sedentary lives. The difference, however, was not so manifest in the inspiratory as in the expiratory efforts, owing to the fact that the muscles concerned in the former were most frequently brought into play in many of the ordinary avocations of life.

The above conclusions, the result of direct experiment, are certainly in strict conformity with what might have been anticipated by mere reflection upon the subject; for, whilst it appears reasonable to suppose that healthy men, having the same physical development, should be possessed of a like vital capacity, it is also equally apparent that the well-developed man, in the prime of life, and engaged in some active pursuit, should have greater capacity than the one who is small, feeble, or of sedentary habits. Supposing that by the above rules the healthy standard of an individual could be ascertained, it certainly appears probable that any marked deficiency in this respect might fairly be ascribed to disease; at the same time, it is important that the strength of the patient should be taken into the calculation, and that a reasonable allowance should be made when this is defective. In the *Medical Examiner*, vol. viii. p. 51, are some remarks by Prof. Jackson on the spirometer, in the course of which, he states it as his opinion that it is muscular power, and not height, that governs the vital capacity; and this view appears in a measure to be sustained by the fact that in those pursuits which are best calculated for the development of the respiratory muscles, we also find the greatest capacity. With the view of testing this, as also several other points of interest in connection with this subject, I was induced to use the spirometer in a variety of pulmonary affections that came under my notice in the wards of the hospital during the spring of 1852; at the same time, the vital capacity of healthy individuals was obtained, as also that of several suffering with cardiac disease, and of others convalescing from acute affections, so that I might be enabled to form a comparative estimate in these different cases. The instrument used was made after the plan recommended by Mr. McEuen; consisting of a cylinder containing water, into which another cylinder is inverted, this latter being counterpoised by a weight attached to a cord, and also having a small aperture to which is adapted a movable piece of metal, so as to allow the escape of air when the cylinder is depressed. The cord passes over a wheel about one foot in diameter, which rotates as the cylinder ascends from the pressure of the expired air, and points out by means of a scale and index the number of cubic inches introduced. The person using the instrument, after a forcible inspiration, expires through a flexible tube which communicates with the lower part of the inverted cylinder.

	Circumference.	Height.	Weight.	Mobility.	Vital capacity.	Occupation.	Age.
1	28	5.6	120	2¾	160	Physician	45
2	32	5.7¼	131	2	225	Seaman	41
3	37	5.4	145	4	270	"	24
4	37½	5.9	180	4	210	Physician	42
5	34	5.5¼	128	4	230	Seaman	21
6	38	5.10½	202½	4	270	"	27
7	36	5.6	141	3½	230	"	19
8	32	5.6½	134	4	210	"	22
9	35	5.8	153¼	4	230	"	36
10	35	5.8	161	5	250	"	24
11	38	5.10	169½	2½	270	"	28
12	36	5.8	160	3¼	180	"	23
13	34	5.8¼	151	3	250	Physician	21
14	33	5.7	122	3½	250	Labourer	23
15	32	5.7¾	123	2	210	Watch-case maker	23
16	37½	5.10¼	165	3½	200	Seaman	45
17	32	5.5	124	2½	220	Turner	18
18	33	6.	151	3	230	Moulder	19
19	34	5.10	147¾	4	250	Physician	24
20	32	5.10	144	3	225	"	23
Mean	34½	5.8	148	3⅓	228		27

All the persons referred to in this table were in good health, and it will be perceived that the mean vital capacity, as also the circumference and mobility of the chest, are unusually great, whilst at the same time the average height is only five feet six inches; inasmuch as three-fourths of them were seamen, or persons engaged in some active pursuit calculated to invigorate the respiratory muscles, it appears reasonable to conclude that their large vital capacity depended in a measure upon this cause. On the other hand, when we come to examine the individual cases, it will be perceived that the greatest capacity frequently coincided with the greatest height; thus Nos. 6 and 11 had a capacity of 270 cubic inches and a height of five feet ten inches; so it is with Nos. 10 and 13, who were fully five feet eight, and had a capacity of 250. Nos. 3 and 18, however, present very striking exceptions to this rule, the former, with a capacity of 270, being only five feet four inches high, whilst the latter, although six feet, had but a capacity of 230; it is important, however, to bear in mind that the first named had a circumference of thirty-seven and a mobility of four inches, and that at the same time he was a man of unusual muscular development, whereas the second had but a circumference of thirty-three and a mobility of three. The above table also presents several other points of interest, but the number of persons referred to is perhaps too small to enable us to generalize from them.

With the view of still further ascertaining the influence of strength upon vital capacity, the spirometer was used by several persons just convalescing from severe illness; and who, consequently, were more or less feeble, though free from all pulmonary or other disease.

	Circumference.	Height.	Weight.	Mobility.	Vital capacity.	Occupation.	Age.	Convalescent from
1	32	5.7	108	4½	120	Labourer	21	Typhoid fever.
2	32	5.9	121	3	220	Seaman	22	" "
3	35	5.8½	137	4	190	Labourer	34	" "
4	32	5.5¾	103½	3	210	Waiter	25	Hæmaturia.
5	33	5.4	115	2½	130	Weaver	30	Acute rheumatism.
Mean	33	5.6	117	3⅖	174		26	

As far as the limited number of cases in the above table can prove anything, they certainly go to show that mere debility may very materially diminish vital capacity; the mean being but 174, or about 40 cubic inches less than when the strength is unimpaired. It should be observed, however, that the weight was also below par.

As the amount of air drawn into the lungs by forced inspiration must necessarily be more or less influenced by whatever tends to obstruct or diminish the size of the bronchial tubes, it appears reasonable to conclude that the vital capacity would be impaired in bronchitis, or mere congestion of the bronchial mucous membrane. The following cases were selected to test this point:—

	Circumference.	Height.	Weight.	Mobility.	Vital capacity.	Occupation.	Age.	Disease.
1	36	5.5	131	4	230	Weaver	40	Chronic bronchitis.
2	34	5.4¾	127	5	190	Seaman	30	Acute "
3	35	5.7¾	140	4	200	"	28	" "
Mean	35	5.6	132	4⅓	206		32	

The first case was of four months' duration, and was attended with sonorous and mucous râles throughout the posterior parts of both lungs; the general health and strength, however, were but little if at all impaired. Under the use of the balsam of copaiva, he rapidly improved, and was discharged well about one month after admission. The second came into the hospital suffering with jaundice, and the bronchial affection supervened whilst in the institution. He was somewhat oppressed, and sonorous and sibilant râles could be heard throughout both lungs, but more especially on the right side. Expectoration muco-puriform, prostration slight. The last case was recent, and unattended by marked constitutional disturbance. The usual râles existed in the posterior part of the lungs to a considerable extent. When we consider that one of these patients was more or less exhausted by previous disease, and that two of them were below the average height and weight, it would appear that their vital capacity was scarcely diminished by the bronchial affection; this result is contrary to what might have been anticipated, and is probably owing to the circumstance of the inflammation not having extended to the minute bronchial tubes.

In cases of cardiac disease, it is well known that the lungs frequently become congested, giving rise to asthma, pulmonary apoplexy, or œdema; and it, therefore, appeared of some interest to ascertain how far the vital capacity might be diminished under such circumstances. With this view, the following cases were selected :—

	Circumference.	Height.	Weight.	Mobility.	Vital capacity.	Occupation.	Age.	Disease.
1	33	5.4½	131	2¾	130	Seaman	39	Hypertrophy with disease of aortic valves.
2	33	5.7¼	136½	2½	160	Coachman	27	Hypertrophy with disease of mitral valves.
3	36½	5.9¾	176	2¾	100	Well-digger	39	Slight hypertrophy with disease of aorta.
Mean	34	5.6	148	2⅔	130		35	

In the first, there was extensive dulness on percussion over the cardiac region, with increased impulse, and a harsh, bellows sound, heard more distinctly along the aorta than over the apex of the heart. He was somewhat oppressed upon taking exercise, but had no dropsy, nor was his strength impaired. His disease was attributed to an injury received two months before admission. In the second, the dulness of the cardiac region was also very great, and this part of the chest was slightly bulging; a double bellows, or saw sound, was heard over the same extent, but was most marked over the apex of the heart; the impulse of the heart was also much increased. The disease could be distinctly traced to a rheumatic attack with which the patient had suffered the previous year. In the last, there was œdema of the lower extremities, and considerable oppression; the respiratory murmur at the lower part of both lungs was in a measure marked by a subcrepitant râle, most probably the result of pulmonary œdema. Over the heart a distant rasping sound could be heard, but this was much louder over the sternum and in the course of the aorta. The disease was probably induced by intemperance and hard work.

In the first two cases, it will be perceived that the vital capacity and mobility are greatly diminished, and yet in neither of them was there any sign indicative of pulmonary disease. In the last case, however, the œdema of the lungs fully accounts for the imperfect respiratory movements. Judging from the above results, it would appear not improbable that extensive cardiac disease tends to diminish vital capacity—the average in these cases being only 130, or 95 less than in health. The mere debility was not sufficient to account for so great a deficiency.

Dr. Hutchinson refers to a case in which the pleuræ were adherent throughout, without having interfered with the mobility or capacity of the chest; and, from this single instance, is disposed to conclude (contrary to the generally received opinion) that freedom of respiratory movement is not prevented by such adhesions. He does not, however, state the character of the adhesions, whether loose and cellular, or firm and cartilaginous, or as the result of acute or chronic inflammation. And yet these distinctions are important; since, in the former, we can readily understand that the thoracic movements are but little impeded; whereas, in the latter, the contrary must necessarily pertain. The four cases of pleurisy referred to below may not prove uninteresting, as showing the influence of this disease upon vital capacity.

	Circumference.	Height.	Weight.	Mobility.	Vital capacity.	Occupation.	Age.	Disease.
1	30	5.1	104	2½	100	Cook	24	Chronic pleurisy.
2	35	5.4½	134	4	140	Stonemason	31	Pleuritic effusion.
3	29	5.4	113	2	126	Domestic	36	Adhesions of pleuræ.
4	33½	5.7½	133	2½	170	Brickmaker	27	Pleuritic effusion.
Mean	32	5.4	121	2¾	132		29	

The first was that of a female who entered the hospital January, 1852, with pleuritic effusion of left side, as indicated by dulness of percussion, slight prominence, feebleness of respiration, and ægophonic resonance of the voice. The spirometer was not used in her case until March, when the above result was obtained; by this time, however, the effusion had in a great measure disappeared, but the side still remained flat and contracted, and the respiration feeble. About the middle of the month following (April), she was again seized with pleurisy of the right side, and attended by the usual signs indicative of effusion; at this time, the spirometer was once more used, and showed a loss of forty cubic inches since the first observation—her vital capacity now being only sixty; the mobility was also reduced to two inches, but at the same time her strength had improved, and she had gained seven pounds in weight. It will thus be perceived that both capacity and mobility were considerably diminished by old adhesions of the pleura, and that they were still further impaired by a moderate effusion on the opposite side. These results could not be ascribed to pain, since the patient was not suffering at the time the instrument was used. In the second, the disease was of three weeks' standing, and was evidently attended with considerable effusion into the right pleural cavity, as manifested by slight bulging at the lower part of the thorax—the respiratory murmur being inaudible at this part, but supplementary throughout the sound side—and also by dulness of percussion, which could be varied by changing the position of the patient. Here again the capacity was below the natural standard, as might have been anticipated from the pressure of the fluid upon the lung. His strength was but little impaired, and his occupation was well calculated to develop the muscular system. The third case was that of a female who had suffered with occasional stitches of the left side for several weeks before admission; the lower two-thirds of left thorax were dull and motionless, and the respiratory murmur was greatly diminished over the same extent; in the axillary region, however, there was a distinct friction-sound. No signs of tubercular deposit could be detected, and at the end of one month she left the hospital perfectly well. In this instance, the low vital capacity may fairly be attributed to pleuritic adhesions. The fourth and last case entered the hospital in May, having some weeks previously experienced severe pain of the left side; his strength, however, was not much reduced at the time of admission. Over the lower half of left thorax the vesicular murmur was scarcely audible; at this part, the percussion was also flat, and its extent could be varied by changing the position of the patient; he experienced slight difficulty of breathing upon taking exercise, but had neither cough nor expectoration. By the end of one month he had gained six pounds in weight, and most of the physical signs indicative of effusion had disappeared; the spirometer now showed a gain of thirty cubic inches in his vital capacity. In this instance, it is evident that the capacity was at first diminished by the effusion, and that it gradually improved as absorption went on; the remaining deficiency was probably due to the consequent pleuritic adhesions.

It is, however, especially in phthisis that the spirometer has been considered most useful in forming a correct diagnosis; and allusion has already been made to the opinions of Dr. Hutchinson upon this subject. According to this author, the disease may be detected in its very incipiency by the aid of this instrument, since a very small deposition of tuberculous matter will cause a considerable deficiency in the vital capacity. In confirmation of this opinion, he mentions the case of a young man who presented all the appearances of full health, but whose vital capacity was forty-seven cubic inches below the healthy standard; one week after using the spirometer, he had an opportunity of examining the lungs, and "found the left lung at the apex studded with miliary tubercles; the whole not extending beyond a square inch, the entire remaining portion being to all appearance healthy:" at the same time, he admits that it is difficult to comprehend why it is that the difference of the vital capacity should be so great when the organic disease is apparently so little. That so limited a tubercular deposit as that just alluded to should *per se* very materially interfere with the vital capacity is indeed quite inconceivable; and it is by no means improbable that the deficiency might in a great measure have been owing to some modifying influence which escaped the observer's attention. In a subject so complex, and where the results are so readily influenced by slight and perhaps inappreciable causes, we cannot be too careful how we generalize from a single fact; at the same time, I am by no means disposed to disparage the utility of the spirometer for the detection of some of the latent forms of phthisis, and particularly when the tubercles are numerous, and yet so disseminated as to give rise to but few if any marked physical signs. Under such circumstances, it is quite conceivable that the vital capacity might be greatly impaired; and when such deficiency could not be accounted for on the score of debility, bronchitis, pleurisy, or other disease, it might fairly be ascribed to the presence of tubercle. Moreover, even in those cases where both auscultation and percussion fully reveal the true nature of the case, they may not always point out the full extent of the disease, owing to the circumstance of a large portion of the lungs still being permeable to the air, and, consequently, not affording a good conducting medium. Most practitioners must have met with instances in which an examination *post mortem* showed a far greater amount of tubercular deposit than had been indicated by the physical signs; and it is highly probable that under such circumstances our prognosis as to the duration of life would have been more correct had the indications afforded by the spirometer entered into the calculation, since in all probability the vital capacity would have been found far below what might have been anticipated from the mere physical signs or other accompanying circumstances. Although, as a general rule, it may be true that the more the lungs are obstructed by tubercles the less will be their capacity, still, it will occasionally happen that, even when the physical signs afford unequivocal evidence of considerable local disease, the vital capacity will be but little below the healthy standard—not more perhaps than could be fully explained by the accompanying debility. But, before proceeding further, let us examine the general result obtained from the use of the spirometer in the various stages of phthisis; with this view, the following cases have been arranged in the tabular form, whilst at the same time a brief note of the stethoscopic indications will be appended, so that the reader, by referring to the corresponding numbers, may at once be enabled to see the pathological condition of the lungs (as revealed by the physical signs) in connection with the vital capacity.

CONFIRMED OR ADVANCED PHTHISIS.

	Circumference.	Height.	Weight.	Mobility.	Vital capacity.	Occupation.	Age.
1	33	5.10½	140	2	150	Stonemason	30
2	33	5.6	126½	2½	140	Weaver	38
3	36	5.9½	148	3½	150	Blacksmith	22
4	33½	5.7¾	127	3	190	Porter	22
5	33½	5.6½	133	3	180	Seaman	54
6	32	5.6½	140	2	135	"	21
7	31½	5 3	110	2	110	Domestic	22
8	34	5.6	114½	2½	110	Hod-carrier	33
9	31½	5.7	123½	3	140	Harness-maker	52
10	31	5.4	101	1	80	Seaman	54
11	31	5.3	113	2	50	"	38
12	33	5.8	132	2½	110	Stonecutter	22
13	35	5.7½	135	2½	135	Shoemaker	35
14	31	5.4½	113	2	90	Printer	18
15	30½	5.4	114	2½	80	Labourer	18
16	26	4.6	61½	1½	40	Domestic	14
17	34	5.5½	128½	2	130	Seaman	45
18	32	5.7	148	2	80	Labourer	25
19	31	5.6	106	2	120	Silversmith	40
20	32	5.7	139	2	80	Labourer	25
21	31	5.4¾	96	2½	100	Harness-maker	41
22	31½	5.8¾	116	3	100	Seaman	41
23	34	5.6	113	2½	80	Hod-carrier	33
Mean	32	5.6	120	2¼	112		32

INCIPIENT PHTHISIS.

	Circumference.	Height.	Weight.	Mobility.	Vital capacity.	Occupation.	Age.
24	34	5.7	146	3½	220	Boatman	21
25	36	5.8	144	2	160	Farmer	26
26	36	5.7½	150	4	150	Carter	48
27	31½	5.10½	128	3	140	Plumber	18
Mean	34	5.8	142	3	167		28

1. Had cough for five months, with occasional attacks of hæmoptysis; at time of admission, he was pale, thin, and feeble, and suffered with hectic fever. Percussion flat under left clavicle, with cavernous respiration, gurgling, and pectoriloquism; right lung apparently healthy.

2. Never had hæmoptysis, but has had cough for eighteen months with puriform expectoration, emaciation, and slight hectic fever. Percussion dull under right clavicle, with bronchial respiration and some vocal resonance; prolonged expiration under left clavicle, with crackling.

3. Several of his family have died of consumption, and he has had two attacks of hæmoptysis, followed by cough, puriform expectoration, and hectic fever. Feebleness of respiration with slight mucous râle at summit of left

lung, both behind and in front, but without dulness of percussion or bronchial respiration.

4. Cough for six months preceded by hæmoptysis, but was neither emaciated nor feeble. Expectoration puriform, but without marked hectic. Feebleness of respiration, with dulness on percussion and crackling at summit of left lung; jerking inspiration under right clavicle.

5. This patient was pale and emaciated, but had no hectic fever at time of admission; he had dry cough for two years, during which time he had one or two attacks of hæmoptysis. At summit of right lung, both in front and behind, the respiration was bronchial, whilst under the left clavicle it was feeble, and the percussion dull.

6. His mother had died in a rapid consumption; he had been troubled with cough for about four months, but never had hæmoptysis; at time of admission, he was pale, though not much emaciated, and had hectic fever every evening. Dulness on percussion with *bruit de pot fêlé* under left clavicle, as also gurgling and pectoriloquism. Jerking inspiration and prolonged expiration under right clavicle. Expectoration nummular, ℥iv per diem.

7. She had suffered with spasmodic cough for about one year; was pale and feeble, and had copious purulent expectoration with hectic fever. Catamenia ceased for the last six months. Want of mobility under left clavicle, with flat percussion, *bruit de pot fêlé*, gurgling and cavernous respiration. No marked physical signs on the right side.

8. The disease commenced with the usual symptoms of bronchitis; but these were soon succeeded by hæmoptysis, hectic fever, and more or less prostration. When tested by the spirometer, there was dulness on percussion with feebleness of respiration and crackling under the left clavicle, whilst throughout the same side there was considerable mucous râle.

9. States that he has had cough for six months, followed by a severe attack of hæmoptysis; he also had profuse night-sweats and purulent expectoration. Feeble respiration with crackling under right clavicle, as also above spine of scapula of same side, with dulness on percussion and blowing respiration at summit of right lung.

10. This man was admitted with pleurisy of right side, attended with the usual signs of extensive effusion; hectic fever soon set in, and was followed by puriform expectoration, great emaciation and prostration; he also had chronic laryngitis. When tested by the spirometer, he presented the following signs: right side of thorax contracted and perfectly flat on percussion, with feebleness of respiration and slight vocal resonance, particularly about the root of the lung. Under the clavicle of same side, the percussion was dull, and the respiration feeble and more or less obscured by mucous râle. Chronic pleurisy with probable tubercular deposit.

11. States that he has had cough for fully nine years, and that several of his family had died of consumption. When he entered the hospital, his feet and legs were much swollen; he also had hectic fever, and was considerably

emaciated. Amphoric respiration under right clavicle, with *bruit de pot fêlé*, and dulness extending down to nipple. Under the use of cod-liver oil, he gained twelve pounds of flesh in the course of forty days, but the vital capacity and physical signs remained much the same as at first report.

12. Eighteen months previous to admission, he had an attack of pneumonia, since when the cough has continued, with hectic fever, purulent expectoration, and an occasional hæmoptysis. Crackling under both clavicles, with prolonged expiratory murmur, and some dulness on percussion. Strength moderate.

13. Suffered with chronic laryngitis for the last four months; several years ago he had a hemorrhage from the lungs, amounting to about one pint; since when he has had hectic fever and occasional night-sweats. At time of admission, he was thin but not emaciated, nor was his strength much impaired. Short jerking respiration under left clavicle, with dulness on percussion above spine of scapula of same side. Right lung apparently healthy. Sputa about ℥iij.

14. This patient has suffered with cough and anasarca for four months previous to admission, and had lost flesh and strength. Expectoration puriform, and he also had occasional hectic paroxysms. One of his family had died of phthisis. Crackling under left clavicle with prolonged expiration; dulness and depression of left infra-clavicular region.

15. He was somewhat emaciated and feeble, and had night-sweats, with cough for four months before admission. Dulness at summit of left lung, with feeble respiration and crackling, and prolonged expiration under right clavicle. Mucous râle throughout left lung behind. Sputa ℥iv. Under the use of cod-liver oil, he improved in flesh and strength, and was again tested by the spirometer about one month after the result in the above table had been obtained; he could now blow ninety, showing a gain of ten cubic inches.

16. She had slight hæmoptysis about four months before admission, and this was followed by cough and diarrhœa; she was pale and thin, but not very feeble. There was great fulness of the epigastric region, evidently depending upon an enlargement of the liver. Flatness and crackling at summit of left lung; right lung apparently healthy.

17. This patient had syphilis about three years ago, since when he had complained of sore throat; for the last four months, cough, hectic fever, and emaciation have supervened. Copious puriform expectoration. Lower two-thirds of right thorax flat and bulging, with feeble murmur over same extent; percussion dull under left clavicle, with *bruit de pot fêlé*, gurgling, and cavernous respiration. By the end of one month, the effusion into the right pleura had entirely disappeared, and, under the use of cod-liver oil, he had also gained flesh and strength; the physical signs, however, showed that the disease of the left lung had increased, and, when again tested by the spirometer, it was found that his vital capacity had diminished ten cubic inches. About this time he was seized with acute dysentery, which soon proved fatal. An examination

post mortem revealed extensive pleuritic adhesions of right side, and a large vomica at summit of left lung, in connection with numerous tubercles of both sides.

18. Cough for six months, but without hereditary predisposition to phthisis, and never had hæmoptysis; he attributed his sickness to an inflammation of the lung contracted several weeks before admission. Dulness on percussion, with bronchial respiration and bronchophony under right clavicle, with more or less subcrepitant râle and dulness throughout same lung; sputa slightly rusty; supplementary respiration on left side. After one month's residence in the hospital, his sputa became puriform, and under the right clavicle could now be detected amphoric respiration, pectoriloquism, *bruit de pot fêlé*, and metallic tinkling; the spirometer, however, gave the same result as stated in the table. Chronic pneumonia probably ending in tubercular deposit and ulceration.

19. Stated that he had cough for four years, but that it had become particularly troublesome for three months previous to his admission, during which time he had lost 20 pounds in weight. Hectic fever, huskiness of voice, and purulent expectoration. His mother had died of consumption. Cavernous respiration and gurgling, with flat percussion and want of mobility under the left clavicle. Bronchial respiration and jerking inspiration at summit of right lung.

20. Cough of three months' duration, with copious puriform expectoration and hectic fever. He ascribes his disease to exposure. Dull percussion and cavernous respiration, with gurgling and great vocal resonance under right clavicle, as also at upper part of same lung behind; left lung comparatively healthy, but the respiration was puerile on this side.

21. Stated that he had more or less dry cough for four or five years, but that he never had hæmoptysis. Four months before admission, he commenced to emaciate, and during that time he had lost fifty pounds in weight. Upon slight exercise, he became oppressed, and had some œdema of feet. Well-marked signs of large vomica below right clavicle, such as metallic tinkling, amphoric respiration, and tympanitic percussion; dulness and prolonged expiration under the left. Purulent expectoration about ℥viij per diem.

22. Never had hæmoptysis, but has been troubled with cough for about eleven months; and, at time of admission, was emaciated and feeble; sputa fetid and nummular. He had lost a sister of consumption. Want of motion under right clavicle, with flat percussion, cavernous respiration, and gurgling. The same signs could even be detected behind at summit of lung. Under the left clavicle the respiration was rude, but without dulness on percussion.

23. Cough for seven months, which could be traced to an attack of pleurisy. None of his family had died of consumption, nor had he ever had hæmoptysis. He was emaciated and feeble; expectoration purulent. Crackling and sonorous râle, with absence of respiratory murmur under left clavicle; mucous râles

throughout same side; right lung comparatively healthy, but deep inspiration developed slight crackling under the clavicle.

24. This man entered the hospital with a slight laryngitis, for several months previous to which time he had been somewhat troubled with cough; his strength and general appearance were, however, but little impaired. His mother had died of phthisis. Slight dulness, with jerking inspiration and prolonged expiratory murmur, were the only physical signs that could be detected. Along the aorta and subclavians there was a distinct musical bellows sound, most probably depending upon anæmia.

25. He entered the hospital with anasarca, unconnected, however, with any appreciable disease of heart, liver, or kidneys; he, moreover, had cough, but without decided hectic. Slight dulness under right clavicle, with feeble respiration, and some crepitant râle above spine of scapula. Left lung apparently healthy.

26. Had cough for seven months, without hectic fever or purulent expectoration; nor was his general health materially impaired, though he was evidently somewhat anæmic. Slight crackling under left clavicle, with prolonged expiration, and obscure dulness of percussion. No physical signs on right side.

27. Pale and somewhat emaciated, with cough for the last two or three months. His mother had died of phthisis; and, upon several occasions, he has had hæmoptysis. At times he had night-sweats, and his expectoration, though but small in quantity, was puriform. Slight dulness of percussion, with feeble respiration and mucous râle under left clavicle; sonorous râles throughout right lung.

The mean vital capacity of twenty-two cases of phthisis, in the early stage, was found by Dr. Hutchinson to be about 159; whereas in nine cases, in the advanced stage, it was but 83 cubic inches. By the above table, it will be perceived that the result was somewhat different; thus, in the advanced stage, the vital capacity was 112, or about one-half the average healthy standard, whilst in the incipient form it was 167; showing a loss of about 85, the mean in healthy persons being considered 225. This apparent discrepancy may no doubt in a great measure depend upon some important difference in the extent of pulmonary disease in the cases tested by the spirometer, and merely referred to by Dr. Hutchinson, under the general heads of *early* and *advanced* stage, and unaccompanied by any notes explanatory of the exact condition of the lungs in each case. The general result, however, in both series, shows that the vital capacity is very greatly impaired in the advanced state of consumption; more so, perhaps, than in most other affections of the chest. Thus, in pleurisy (including both effusion and adhesions) the loss was 93 cubic inches, in bronchitis but 19, and in extensive cardiac disease 95; whereas, in advanced phthisis, as shown by my observations, the loss was 112, or about one-half, and, according to the above-named author, even as great as 137. The only case of well-marked emphysema that came under my notice, at the time of making the present report, had a vital capacity of 95; but in this instance the health was unimpaired, and the patient weighed 100 pounds, and was only five feet high; so that, according to the rules before mentioned, there was no very great deficiency. In regard to incipient phthisis, or the early stage of this disease, it will be perceived that the mean capacity was 167, or 58 below the healthy average. Dr. Hutchinson, however, in similar cases, found a deficiency of 67; and, taking it for granted that this result is perhaps the most correct (since it is based upon a greater number of observations), it is still evident that other causes than tubercular deposit might produce a like result. We have seen that by mere debility the vital capacity may be lowered about 50 cubic inches; whatever tends to prevent the free descent of the diaphragm, such as a full stomach, enlargement of the liver and spleen, or other abdominal affections, would also necessarily tend to increase this deficiency. Allusion has already been made to the influence exerted by occupation, and various thoracic affections in this respect.

By examining the last table, in connection with the appended notes, it will generally be found, as might have been anticipated, that the lowest vital capacity corresponds with the greatest amount of pulmonary disease. Thus, in Nos. 10, 15, 18, 20, and 23, it was but 80. In the first of these cases, however, much of the deficiency depended upon chronic pleurisy; whilst in the second and last the extensive bronchial complication had much to do with the result. So, on the other hand, the greatest capacity generally occurred where the disease was least extensive; this is true in regard to Nos. 1, 2, 3, 4, and 5, in which the vital capacity ranged from 140 to 190. In the first case, it will be observed that there existed the unequivocal signs of a vomica; it should, however, be stated, that in this instance the disease appeared confined to the upper part of left lung. In No. 24, the first reported under the head of incipient phthisis, it will also be perceived that whilst the vital capacity was but little, if at all, impaired, the physical signs also revealed no considerable amount of disease.

Although the number of cases may be too limited to enable us to arrive at any positive conclusions as to the utility of the spirometer for the detection of pulmonary tubercles, it is still evident, from the above data, that it may occasionally afford material aid in forming a correct diagnosis. Thus, when the vital capacity is relatively large, it is more than probable that no considerable disease of the lungs can exist. So, too, when it is decidedly below par, we may infer that there are tubercles, *provided* the deficiency cannot be accounted for by debility and other conditions or diseases calculated to impair the respiratory movements. And this conclusion may even be received as highly probable, notwithstanding the absence of the usual physical signs; since, as before stated, there are certainly occasional cases in which disseminated tubercles are not positively revealed, either by auscultation or percussion. The instrument, it is true, is both simple and of easy application, but much judgment and discrimination are requisite for the full interpretation of the results. Nor is it always an easy matter to appreciate fully or apportion the exact influence of the various concomitant circumstances which so much modify the vital capacity; and it is for this reason that we are more liable to be misled by the spirometer than by the stethoscope. How far the rules laid down by Dr. Hutchinson may tend to obviate this difficulty it remains for further observation to decide.

In drawing up the above report, I was much assisted by the accurate notes furnished by Dr. A. Hewson, Resident Physician; and it at the same time affords me much pleasure to acknowledge his valuable aid in testing the various cases by the spirometer and scale-balance.

ART. II.—*Notes from my Case-Book.* By FLEETWOOD CHURCHILL, M. D., M. R. I. A., Fellow of the King and Queen's College of Physicians, Ireland.

Intestinal Irritation in Childbed.—A kind of feverish attack, occurring in childbed, was epidemic in Dublin in 1851. In the course of six months, eight or ten cases came under my own observation. It was something like "weid," but with a considerable difference; yet it differed still more from any variety of puerperal fever. I cannot even say that it is peculiar to lying-in women, for it does not appear to have any direct connection with, or relation to, the uterine system, but it is apparently a short attack of fever, with gastro-intestinal irritation, occurring at that peculiar time.

Perhaps a sketch of two or three of the cases may render the subject more intelligible.

CASE I.—Mrs. —— was confined of her tenth child in July, 1851. The labour was natural, the lochia and milk secreted amply, and she progressed favourably until the eleventh day. On the morning of that day, on which she was to leave her bed for the first time, before attempting to rise or dress, and without the slightest apparent cause, she was attacked with a rigor followed by heat and sweating. The pulse became quick and remained at about 100. The tongue became furred and white; the bowels flatulent and constipated. The milk, which had been abundant, almost entirely disappeared. The uterus was neither enlarged nor painful, nor was there any tenderness on pressure. The lochia continued natural in character though diminished in quantity. A day or two afterwards, the bowels, which had been freed by medicine, became too much relaxed, accompanied by a most distressing amount of flatulence and frequent griping pain. The pulse very slowly diminished in frequency, and the milk gradually returned. Throughout, the uterus and its secretion were apparently unaffected. On the morning of the eighteenth day the patient appeared much better, nearly convalescent; but, in the course of the day, she had another rigor, followed by fever, which subsided, after twenty-four hours, like an attack of weid. From this time, her convalescence was uninterrupted, though slow, and the milk was ultimately restored to its usual abundance.